## Estimating the Relationship Between the Boxed-Beef Cutout Values and Cattle Prices

The mistake in the calculation and reporting of the boxed beef cutout values could have indirect effects on the cattle market if the price of live cattle is affected by the reported cutout. To assess the possible effects of cutout value data on the live cattle market, the USDA estimated price transmission equations linking live cattle prices and the cutout values. In these equations, the cutouts determine the prices of cattle.

The relationship among live prices and the cutout values depends on the role the cutout serves in price determination. Two extreme positions on what the cutout is/does are considered. One position is that the cutout does not influence live prices. Cattle feeders and packers would use a wide range of information to determine how cattle are priced. The cutout values might serve only as a useful summary of all information that cattle buyers and sellers use to discover prices. Under this position, the cutout is primarily useful to those who analyze markets and not particularly useful to the market participants. (Note that even if the cutouts are not important to market participants, the participants could still be using the other, more detailed, information provided by AMS in determining prices.) If cutouts are only a useful summary of market information, the miscalculation of the cutout would not have affected the live price of cattle. It would have only confused market analysts. The other extreme position is that cutouts are the only information that cattle feeders and packers use in cattle pricing. Under this position, cutout miscalculations would have a maximum impact on live cattle prices. Intermediate positions between these two extremes are possible; that is, the cutout could be part of the information used to determine cattle prices.

Under normal circumstances it would be impossible to use only statistics on live prices and cutout values to identify one extreme case from the other or from the intermediate cases. Because AMS reported miscalculated cutouts for six weeks beginning in April 2001, there appeared to be sufficient data to distinguish the cases. If cutout values are only a useful summary of information, the live prices of cattle will appear to follow the revised cutouts that AMS reissued. If the cutouts are the only information used in setting cattle prices, then live prices will appear to follow the initially reported cutouts. In the intermediate case, live prices would appear to follow a weighted average of the "correct" and "incorrect" cutouts.

The data set used for estimation includes 124 weekly observations starting at the week ending January 2, 1999, and running through May 12, 2001. The last six weeks of this period are those weeks for which AMS issued revisions. In the first 118 weeks of the sample, the cutout variable was calculated using the voluntary system. In the last 6 weeks, there are two sets of cutout variables. The first is the misreported cutout value that was published initially; the second is the correctly recalculated and published value.

In order to test the role of cutout values in determining the live prices of cattle, the cutout variables were divided into three different variables. The first cutout variable is the voluntary-system cutout for the first 118 weeks, then 0 for the last 6 weeks. Call this first cutout, X1. The other two cutout variables are 0 for the first 118 weeks. The

second cutout variable, X2, is the correctly calculated cutout in the last 6 weeks, and the third cutout, X3, is the incorrectly calculated value.

The first 118 weeks are particularly important because they can establish how live cattle prices respond to (or appear to respond to) the cutout under normal circumstances. The last two cutout variables help to estimate how the miscalculated cutouts affected the live price. The price transmission model is set up such that either the "correct" or "miscalculated" or a mix of the two cutouts determines cattle prices in the last six weeks of the sample. However, the advent of mandatory price reporting is providing new information to the market and the relationship of boxed beef to live cattle prices may still be evolving.

A simple regression equation relating live cattle prices to the cutout can be written:
$Y_w = B_0 + B_1*( X1_w + \alpha X2_w + (1-\alpha)*X3_w ) + e_w$
In the equation above, the "w" subscript refers to a week. The term $e_w$ is a random error term. The terms $B_0$, $B_1$ and $\alpha$ are coefficients. The coefficient, $B_1$, measures the price transmission from the cutout to the live price. In the first 118 weeks, X2 and X3 are zero. The equation shows the relationship between the voluntary-system cutout and the live price. In the last 6 weeks, X1 is zero, and X2 and X3 enter the equation. The coefficient $\alpha$ is a mixing parameter. If $\alpha$ is equal to 1, the live price of cattle is actually determined by the correctly calculated cutout in the last 6 weeks, X2. This would occur if the cutout were only a useful summary of information the market uses in setting cattle prices. If $\alpha$ is equal to 0, then the cutout is *the* information the market uses in setting the live price. Values of $\alpha$ between 0 and 1 represent the intermediate cases. The value of $\alpha$ measures the amount of "correct" information determining the live price of cattle.

In the database that the USDA used for this study there are four live prices for slaughter cattle and a price for feeder steer and four cutout values. The USDA used estimates of the graded cattle production that fell within each of the four cutout classes to create a weighted-average Choice cutout value and a weighted-average Select cutout value.

| **Cattle** | **Boxed Beef Value** |
|---|---|
| 5 Area, 65-85% Choice Steers (Choice steers) | Choice 600-750 lbs. |
| 5 Area, 35-65% Choice Steers (Select steers) | Choice 750-900 lbs. |
| 5 Area, 65-85% Choice Heifers (Choice heifers) | Select 600-750 lbs. |
| 5 Area, 35-65% Choice Heifers (Select heifers) | Select 750-900 lbs. |
| Oklahoma City Feeder Steers, med/large, 750-800 lbs. | |

Each of the four slaughter cattle prices represents a group of cattle with a mixture of Choice and Select cattle. The feeder steers will grow out to some mixture of Choice

and Select steers. Each of these five live prices is likely to be influenced by both Choice and Select cutouts. The regression equations that the USDA estimated can be written as:

$$Y_{i,w} = B_{i,0} + B_{i,c,1}*( X1_{c,w} + \alpha_{i,c}X2_{c,w} + (1-\alpha_{i,c})*X3_{c,w} ) + B_{i,s,1}*( X1_{s,w} + \alpha_{i,s}X2_{s,w} + (1-\alpha_{i,s})*X3_{s,w} ) + e_{i,w}$$

In the equation above, the subscript, "i," refers to one of the five cattle prices. There are now a Choice and Select cutouts, each with its own price transmission coefficient, and two "alpha" coefficients per equation.

All five equations were estimated at the same time using the maximum-likelihood version of seemingly-unrelated regression. The "alpha" coefficients were constrained to lie between 0 and 1. The first set of equations related the level of cattle prices to the cutouts. The estimates showed signs of significant autocorrelation. The equations were then estimated in first-difference form, that is, the regressions compared the week-to-week changes in the live prices to the week-to-week change in the cutout values. Estimating the models in this form essentially eliminated the autocorrelation and substantially reduced the equations' projection errors. The four slaughter-cattle equations' variances were 1/3 the initial size after taking first differences, while the feeder-steer equation's variance was 1/8 the initial size. The models were also estimated using a log-linear form. Differencing this data also greatly improved the statistical properties of the estimates. The loss estimates used in this report were derived using the log-linear models with $\alpha = 0$.

| **R squares for the models with all $\alpha$=0** | | | | |
|---|---|---|---|---|
| | Linear models | | Log-linear models | |
| | Level | Difference | Level | Difference |
| Slaughter steers 35-65% choice | 91.6% | 72.9% | 91.1% | 74.8% |
| Slaughter steers 65-80% choice | 92.4% | 77.4% | 91.8% | 78.7% |
| Slaughter heifers 35-65% choice | 91.0% | 70.3% | 90.3% | 71.5% |
| Slaughter heifers 65-80% choice | 91.5% | 72.1% | 90.7% | 73.1% |
| Oklahoma City Feeder Steers | 53.7% | 62.6% | 55.4% | 64.9% |
| | | | | |
| **Standard errors for the models with all $\alpha$=0** | | | | |
| | Linear models | | Log-linear models | |
| | Level | Difference | Level | Difference |
| Slaughter steers 35-65% choice | 1.52966 | 0.87185 | 0.02233 | 0.01239 |
| Slaughter steers 65-80% choice | 1.45421 | 0.81111 | 0.02148 | 0.01157 |
| Slaughter heifers 35-65% choice | 1.53706 | 0.89010 | 0.02254 | 0.01282 |
| Slaughter heifers 65-80% choice | 1.49161 | 0.86994 | 0.02206 | 0.01255 |
| Oklahoma City Feeder Steers | 4.63668 | 1.59329 | 0.05711 | 0.02005 |

Three versions of each model were run in order to test hypotheses about the cutout's role in setting market prices. One version assumed that the cutouts are only summary

statistics of the actual information used in setting prices, i.e., all the α were fixed to 1. The second alternative fixed all the α at 0; this is equivalent to assuming that the cutouts *are* the information used to set prices. The third allows the α to vary freely between 0 and 1. This third alternative is the least restricted alternative. The first two alternatives are more restricted and were tested against the last alternative.

| **Hypothesis tests on the α** | | | |
|---|---|---|---|
| | | Test | Significance level |
| Linear model | All α are 1 | 15.4574 | 11.63% |
| | All α are 0 | 13.4234 | 20.10% |
| Log-linear model | All α are 1 | 11.6714 | 30.77% |
| | All α are 0 | 10.0900 | 43.26% |

The table above shows the results of the hypothesis tests. The test statistic is a chi-square with 10 degrees of freedom. As shown by the high significance levels, the α do not appear to be precisely estimated. It is not possible to reject either of the extreme roles for the cutout. On the whole, those regressions where the α are forced to be 0 fit better than those where the α are forced to be 1.

When we allow the α to lie between 0 and 1, and let the estimation method determine the optimal value, 5 of the values go to their upper bound of 1, and 5 go to the lower bound of 0. Both the linear and log-linear models show the same pattern of 0's and 1's. There is no consistent pattern to which of the α goes to 0 and which to 1, other than that each of the five prices has one of each. This might explain why models with the α constrained to one or the other extreme value produce similar results. The optimal, estimated α are presented in the table below and the price transmission coefficients are found in the table following that one.

| Optimal α estimate for free models | | |
|---|---|---|
| | Choice | Select |
| Slaughter steers 35-65% Choice | 1 | 0 |
| Slaughter steers 65-80% Choice | 0 | 1 |
| Slaughter heifers 35-65% Choice | 0 | 1 |
| Slaughter heifers 65-80% Choice | 1 | 0 |
| Oklahoma City Feeder Steers | 0 | 1 |

**"B" parameter estimates by model type**

**Linear model estimates**

| | Estimated price transmission from the cutout to the live animal price: Change in live price in $/cwt caused by a $1/cwt change in the cutout | | | | | |
|---|---|---|---|---|---|---|
| | Forcing all the α to be 0 | | Allowing the α to be between 0 and 1 | | Forcing all the α to be 1 | |
| | Choice | Select | Choice | Select | Choice | Select |
| Slaughter steers 35-65% Choice | 0.049 | 0.206 | 0.054 | 0.196 | 0.021 | 0.264 |
| Slaughter steers 65-80% Choice | 0.052 | 0.220 | 0.055 | 0.214 | 0.022 | 0.277 |
| Slaughter heifers 35-65% Choice | 0.071 | 0.177 | 0.054 | 0.190 | 0.029 | 0.250 |
| Slaughter heifers 65-80% Choice | 0.059 | 0.198 | 0.063 | 0.190 | 0.033 | 0.254 |
| Oklahoma City Feeder Steers | 0.120 | 0.000 | 0.077 | 0.044 | 0.086 | 0.051 |

**Log-linear model estimates**

| | Forcing all the α to be 0 | | Allowing the α to be between 0 and 1 | | Forcing all the α to be 1 | |
|---|---|---|---|---|---|---|
| | Choice | Select | Choice | Select | Choice | Select |
| Slaughter steers 35-65% Choice | 0.116 | 0.314 | 0.060 | 0.408 | 0.120 | 0.303 |
| Slaughter steers 65-80% Choice | 0.122 | 0.327 | 0.065 | 0.417 | 0.123 | 0.322 |
| Slaughter heifers 35-65% Choice | 0.146 | 0.264 | 0.070 | 0.378 | 0.119 | 0.285 |
| Slaughter heifers 65-80% Choice | 0.134 | 0.284 | 0.079 | 0.377 | 0.136 | 0.277 |
| Oklahoma City Feeder Steers | 0.168 | 0.000 | 0.126 | 0.060 | 0.119 | 0.046 |

The estimates of how much the cutout-reporting errors changed live cattle prices are presented in the table below. If all the α are in fact 1, a hypothesis that cannot be rejected, then cutout-reporting error had no effect on live cattle prices. The largest estimated effect occurs when all the α are forced to be 0. Allowing the software to select the α gives intermediate effects. Using the results when all the α are forced to be 0 gives an upper bound on the effect that the cutout error had on live cattle prices.

| Estimated price changes (in $/cwt) caused by cutout errors | | | | | |
|---|---|---|---|---|---|
| Week | Slaughter steers 35-65% choice | Slaughter steers 65-80% choice | Slaughter heifers 35-65% choice | Slaughter heifers 65-80% choice | Oklahoma City Feeder Steers |
| *Based on the linear model, all α are forced to be 0* | | | | | |
| April 7, 2001 | 0.01 | 0.01 | -0.03 | 0.00 | -0.15 |
| April 14, 2001 | -0.19 | -0.20 | -0.21 | -0.20 | -0.20 |
| April 21, 2001 | -0.30 | -0.31 | -0.32 | -0.31 | -0.27 |
| April 28, 2001 | -0.29 | -0.31 | -0.33 | -0.31 | -0.32 |
| May 5, 2001 | -0.39 | -0.41 | -0.43 | -0.41 | -0.42 |
| May 12, 2001 | -0.46 | -0.49 | -0.54 | -0.50 | -0.61 |
| Average | -0.27 | -0.28 | -0.31 | -0.29 | -0.33 |
| *Based on the log-linear model, all α are forced to be 0* | | | | | |
| April 7, 2001 | -0.02 | -0.02 | -0.05 | -0.04 | -0.14 |
| April 14, 2001 | -0.20 | -0.21 | -0.21 | -0.21 | -0.18 |
| April 21, 2001 | -0.31 | -0.32 | -0.32 | -0.31 | -0.24 |
| April 28, 2001 | -0.32 | -0.33 | -0.34 | -0.33 | -0.29 |
| May 5, 2001 | -0.41 | -0.43 | -0.44 | -0.43 | -0.38 |
| May 12, 2001 | -0.50 | -0.53 | -0.56 | -0.54 | -0.54 |
| Average | -0.29 | -0.31 | -0.32 | -0.31 | -0.30 |
| *Based on the linear model, α are free to lie between 0 &1* | | | | | |
| April 7, 2001 | 0.10 | -0.03 | -0.04 | 0.09 | -0.11 |
| April 14, 2001 | -0.13 | -0.04 | -0.05 | -0.13 | -0.14 |
| April 21, 2001 | -0.24 | -0.05 | -0.06 | -0.23 | -0.19 |
| April 28, 2001 | -0.21 | -0.06 | -0.08 | -0.20 | -0.23 |
| May 5, 2001 | -0.27 | -0.08 | -0.10 | -0.26 | -0.30 |
| May 12, 2001 | -0.27 | -0.11 | -0.15 | -0.26 | -0.44 |
| Average | -0.17 | -0.06 | -0.08 | -0.16 | -0.23 |
| *Based on the log-linear model, α are free to lie between 0 &1* | | | | | |
| April 7, 2001 | 0.09 | -0.05 | -0.05 | 0.08 | -0.10 |
| April 14, 2001 | -0.12 | -0.06 | -0.06 | -0.11 | -0.13 |
| April 21, 2001 | -0.21 | -0.08 | -0.09 | -0.20 | -0.18 |
| April 28, 2001 | -0.19 | -0.10 | -0.10 | -0.17 | -0.22 |
| May 5, 2001 | -0.25 | -0.13 | -0.13 | -0.23 | -0.29 |
| May 12, 2001 | -0.24 | -0.18 | -0.19 | -0.23 | -0.41 |
| Average | -0.15 | -0.10 | -0.11 | -0.14 | -0.22 |

The net effect of the cutout errors on live prices is not large compared to the error in the reported Choice cutouts. One thing to note is that the price transmission from the Select cutout to slaughter-cattle prices tends to be larger than that from the Choice cutout. It appears that the Select cutout is a more important determinant of slaughter cattle prices. The Select cutouts' revisions are smaller than those for the Choice cutouts. This is one reason that the price impacts of the cutout error are relatively small for slaughter cattle. Feeder calf prices are strongly influenced by the Choice cutout in all the estimates, and the estimated impact of the cutout errors on feeder calf pricing are often larger than those on slaughter cattle.